

#### Updates and improvements in the latest PVsyst versions PVPMC Workshop 9,10 May 2023

Salt Lake City, USA

B. Wittmer on behalf of the PVsyst development team PVsyst SA, Switzerland

PVSYST SA - Route de la Maison-Carrée 30 - 1242 Satigny - Suisse www.pvsyst.com

#### **Overview**

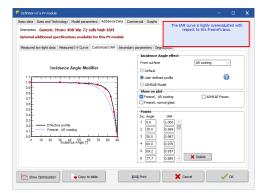
- Last PVPMC in August 2022 -> PVsyst 7.2.18
- Today -> **QPV**SYST v 7.3.4
- Major version 7.3 introduced:
- . Upgrade to Meteonorm 8.1 libraries
- . Single line diagram

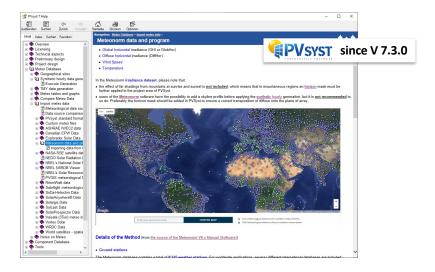
- Database updates
- Shadings in large systems
- Electrical shading calculations
- Single line diagram
- Grid limitation (curtailment)
- Sub-hourly clipping losses
- Other developments
  - More details and customization in results and report
  - More flexibility with orientations
  - Generalized bifacial model
  - Tracker wind stow position
  - Glare analysisc



#### **Databases**

- Meteonorm 8.1 libraries
- Easier importing of data from 3E and NEDO Japan
- Meteo APIs (Solcast, SolarAnywhere, Solargis)
- More power optimizer brands:
  - AMPT
  - Huawei
  - Maxim
  - SolarEdge
  - Sungrow (upcoming)
  - Tigo
- Improved guidance with custom PAN files

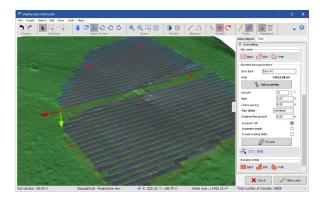


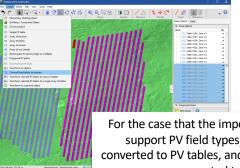




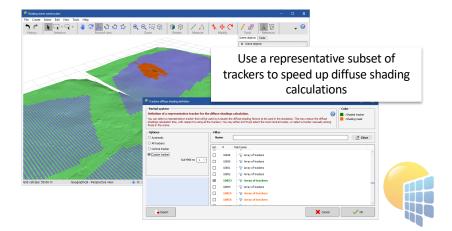
### **Shadings in large systems**

- Improved importing of drawings supported formats : DAE, 3DS, PVC
- Improved tools
  - Table conversion (trackers, table groups)
  - More flexibility with diffuse shading calculation (trackers)
  - More possibilities with ground objects (topography)
  - More options with editing of multiple selections (list of tables with parameters)
  - Performance improvements for large drawings
  - API for Importing of ground image and topography from coordinates 
     API for Importing of ground image and topography from coordinates
     API for Importing of ground image and topography from coordinates

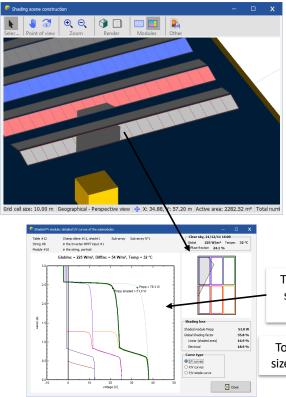




For the case that the imported format does not support PV field types, rectangles can be converted to PV tables, and fixed tilt tables can be converted to trackers



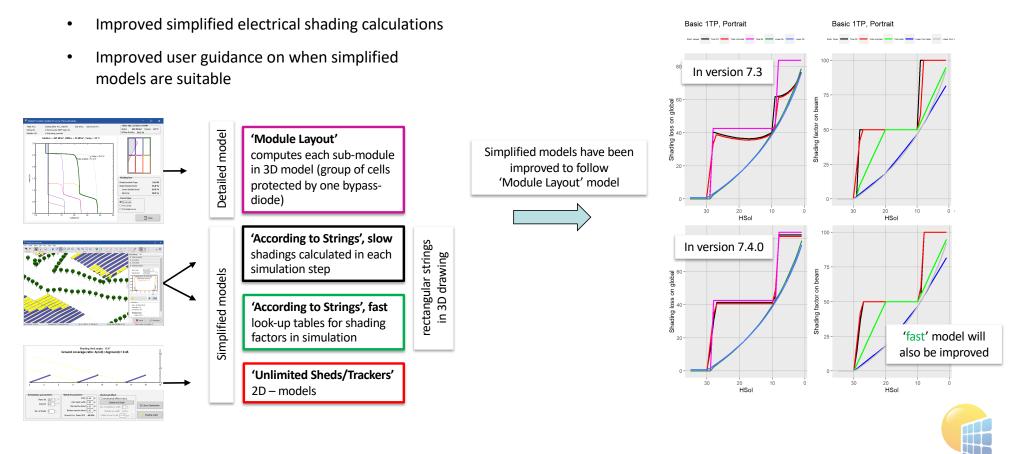
#### **Electrical shadings, PV cell size**



- To allow the detailed computing of the IV-curves in partially shaded PV modules, the PV cell size must be known
- For PV modules with non-square cells width and height can now be different
- The grouping of cells with by-pass diodes has diversified

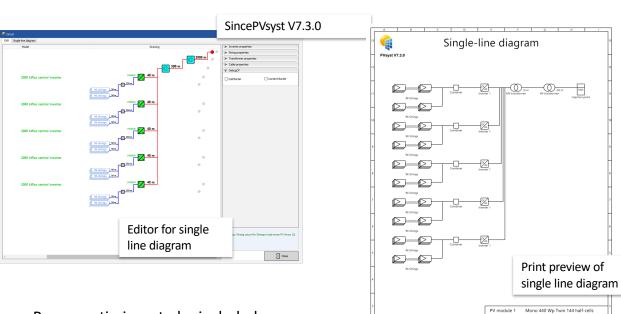
	C Definition of a PV module - C X
32.52 m² Total numi 	Basic data       Sizes and Technology       Model parameters       Additional Data       Commercial       Graphs         Description       Generic, Mono 370 Wp Twin 120 half-cells       Maximum Array Voltage         Module       Cells       In series       60         In parallel       In parallel       In series       1500       V         Nickness       35.0       mm       Cell size       137.8       cm²       Cell size         Module area       1.868       m²       Cell size       1.653       m²       Cell size       3<0       /module       7
The transition between an unshaded and shaded sub-module happens as a single cell gets shaded	Definition of would is sees a management of used for the definition of the Tusual efficiency. Cells area is facultative: if definent allows for the definition of the efficiency at cell level. Module technology and specifities Frame: Algorithm Structure Tempered AR class The module
To compute the IV-curve of the sub-module, the size of one cell and its orientation must be known	Confections: MC-4 Concentrating module Concentrating module Bifacial module
Page 5	Show Optimization Copy to table

#### **Electrical shadings, simplified models**



# **Single Line Diagram**

with with with with with with with with			-	
<pre>bit bit bit bit bit bit bit bit bit bit</pre>			6	List of subarrays
<pre>nt line the the the the the the the the the th</pre>			Enter planned power O 20000.0 kt/p	
www.image.www.i			available area(nodules) O 50557 m <sup>3</sup>	
and we	lect the PV module			
www.initedential interface       www.initedential interface         wwwwwww.initedential interface       www.initeden	alable Nov V Filser All PV modules V			
Image: Section of the serve	leneric 🗸 🖓 (440 Wp 35V Skimone Mono 4	40 Wp Twin 144 half c. Since 2020	Trokal V C, Open	
Image: Section of the serve				
<pre>intermediate intermediate intermediate</pre>		543 V		
			S0 Hz	
Vertication that array     Vertication that array       Vertin that array     <	Generic V 2000 km 800 - 1500 V TL 50.50 H	z 2000 kollac central inverter		1
with with with with with with with with		800-1509 V Global Swerter's pow	er 10000 itta:	5
Image: section of the section of t	Input maximum voltage:	1500 V		
	sion the array			
	iumber of modules and strings 00			
and any				
				Nb. of inverters 5
Name	Plan			
Verden verd		(STC) 20656 A (a	£ 1936 W(in1 and 59*C)	
Configuration of pV system     Configuration of pV system     Configuration of pV system     Configuration     Configuratin     Configuration     Configuration     Configuration     Confi	. modules 25920 Area 57671 ml (k)	01 STC) 20656 A Am	ray nom. Power (STC) 11405 kito	
Configuration of py system     Configuration of py system     Configuration of py system     Configuration     Configuratin     Configuration     Configuration     Configuration     Confi				
Val dataket kanang paraketir     PUS system	2 system overview 2.1° single-line diagram	Config	uration of	👗 Carde 🗸 🗸 Dk
Val dataket kanang paraketir     PUS system		Coning	uration of	-
emageneere of mixing block galry 120 - Mensich block gal (Maass Landers Arg (Maasshir) gottal anders Ar ander block block barry (Mark and Arg		-		
em aparanete (mit imme hada gadi i 120 - Honesti bala gazi (2014ansi kadansi kagi (2014ansi kada sa ka		DV/ cvct	om	
emageneere of mixing block galry 120 - Mensich block gal (Maass Landers Arg (Maasshir) gottal anders Ar ander block block barry (Mark and Arg	V field detailed losses parameter	F V 3V31	LEIII	- 0
Oast Stand and STC     1       Oast Action and STC     7       Of Descendence     7 <tr< th=""><th>ermal parameter Ohmic Losses Module quality - Li</th><th>ID - Mismatch Soling Loss I</th><th>AM Losses Auxiliaries Aging Uni</th><th>avalability Spectral correction</th></tr<>	ermal parameter Ohmic Losses Module quality - Li	ID - Mismatch Soling Loss I	AM Losses Auxiliaries Aging Uni	avalability Spectral correction
Access diver below the sectors     All and a sector of the sectors     All and a sectors     All and	C circuit: ohmic losses for the array Specified by	Calculated	0	MV drouts
At the loss and/or for strate()              grave matrix	C circuit: ohmic losses for the array Specified by @ Global wiring resistance 1.1221 πΩ	Calculated Default	0	MV drouts
Bits A. Could whick is:         Importance is an end of the table when the importance is the table when table when table when table when table when table when table w	C circuit: ohmic losses for the array Specified by (a) Global wiring resistance (b) Li221 mit (c) Loss fraction at STC (c) Li221 %	Calculated Default	0	MV drouts
(a) Society of the test of the	C circuit: ohmic losses for the array           Specified by           @ Global wining resistance           [1:221]           Doss fraction at STC           1:01           viritage Drop scross series diode	Calculated Default	0	MV drouts
Long ID, North 201 TW, Sec. 2010 TW	CC circuit: chinic losses for the array Specified by @ Gobal wring resistance Loss fraction as STC Voltage Drop across series dode 0.7 AC losses after the inverter	V Default	etaled computation	M/ orout: This wire cross-section seems oversed
User of the function         Control         Contro         Control <thcontrol< th=""></thcontrol<>	CC circuit: chmic losses for the array Specified by @ Global wingresstance Loss fraction at STC Loss fraction at STC Attraction at STC Desses after the inverter At Wise loss Inverter to transfo (per inverter	Calculated Default V Confault r) © per inverter	etaled computation	M/ orout: This wire cross-section seems oversed
Strice + 20200, Nor -400 7 Nr. 1 = 553.0         @ cope July         B cope July	C circuit: ohmic losses for the array specified by © Gobal wing resistance List not STC List not STC List not STC C loss factor at STC K losses at fact the inverter K Wreeks Si Inverter to transfor (per inverte St uses AC oncut ohmic loss	Calculated Defsult V © Defsult • • • • • • • • • • • • • • • • • • •	etaled computation	M/ oract: This wire cross-section interna overstand
Undary days d12C         L1V         D.Bu         more speak with transfer and transf	C Grouit obmic losses for the array Specified by  Godal wing resistance I 1122 m2 Goda charm of STC I 112 m2 Goda Charmon STC I 112 m2 Goda Charmon State I 112 m2 Goda Charmon State I 112 Goda Charmon State I 11 Goda Ch	Calculated Default V © Default P O per inverter V Wrose system Wrose system	etaled corputation	M/ oract: This wire cross-section interna overstand
Coper series (M subjects         Coper series	C Grouit obmic losses for the array Specified by  Godal wing resistance I 1122 m2 Goda charm of STC I 112 m2 Goda Charmon STC I 112 m2 Goda Charmon State I 112 m2 Goda Charmon State I 112 Goda Charmon State I 11 Goda Ch	Caladated Default V © Default • • • • • • • • • • • • •	etaled computation	My craut: This wire occases that seems oversized crassformer 
Date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the control of the local date is all for address to the	C circuit chink leaves for the array Specified by 0 cosh array estators 11221 m0 0 cosh action at STC 1111 m0 1111 m0 1112 m0 1112 m0 1111 m0 11111 m0 1111 m0 11111 m0 11111 m0 11111 m0 11111 m0 11111 m0	Calculated Default V Contact V Contact V Contact V Contact Co	etsield computation	MY club: The use consection seems everyood
Tansformer from Statuberts         Tansformer from Statuberts           Reduin Values to injection         0.0         V           Lines Alf to audige the Lines Alf to audige to injection         0.0         V           Lines Alf to audige the Lines Alf to audige to injection         0.0         V           Lines Alf to audige the Lines Alf to audige to audige the Lines Alf to audige the Lines Alf to audige the Lines Alf to audige the Lines Alf to audige the Lines Alf to audige the Lines Alf to audige the Lines Alf to audige the Lines Alf to audige the	C circuit chink leaves for the array Specified by 0 cosh array estators 11221 m0 0 cosh action at STC 1111 m0 1111 m0 1112 m0 1112 m0 1111 m0 11111 m0 1111 m0 11111 m0 11111 m0 11111 m0 11111 m0 11111 m0	Calculated Default V Contact V Contact V Contact V Contact Co	Edided computation     Pledium Voltage external It     Not Transformer(s), full a system     RacBeer of NV transformer(s), full a system     RacBeer of NV transformer(s), full     Decision (construct vulue)     Decision (construct vulue)	M Gradi These access section server severated accession server accession
Interface frage         0.0	Circuit: chains leases for the array           Social of y           O close irray assessment           O close irr	Calculated Default V Contact V Contact V Contact V Contact Co	etiéd computation	Mr cast:           The use case action sense network           Image: Sense case action sense ne
International and and a state of the state of t	C circuit: chink bases for the array- social of by         11221         m0           © close stances         11221         m0           © close stances still C         1125         m0           Ways Do parses stres doke         1.72         m0           Closes after the invorter         Closes stress the based for parses         m0           Closes after the invorter         Closes         m1         m1           Closes after the invorter         Closes         m1         m1           Stor lose act Act and the for handhower         E0.0         m1         m1           StOr lose - 2040 MV, type - 8047 Hr, 1 - 8484 A         M104 do do dt TO         1.11 (P. 0.176)           O close are of coard to Parsefines         1.11 (P. 0.176)         1.11 (P. 0.176)         1.11 (P. 0.176)	Calculated Default V Contact V Contact V Contact V Contact Co	etiled computation  Fieldium Voltage external It  NY Transformer(s), full system  Transformer(s), full system  Externor on Paraficat  Externor on Parafic  Transformer(s) soar  T	M Grafi The we cause section server overveel
Length MT Transfo to Figuction         548         m         Wite sector         0         Via         MiA           Loss R Action 4137C         0         0         Sommer*         If         If         MiA         MiA           Closer R Action 4137C         0         Sommer*         If         If         MiA         MiA         MiA           Closer R Action 4137C         0         Open*         If         MiA	C directil: chimic leases for the array Social data         1321         n0.           Could harmy states         10.         n7.           Could harmy states and states         10.         n7.           Classes after the inverter         A three loss inverter to harding data variations at three loss interfloation at three loss inthree loss interfloation at three loss interfloation	Calculated Default V Contact V Contact V Contact V Contact Co	Hodum Voltage external 1     Horizage external 1	M Grafi The we cause section server overveel
Length MT Transforb to Injection         VM         IW We section         Copport (relistive) loss at Phion         NA         MIA           Length MT Transforb to Injection         0.30         %         300 mm²         Q         Copport (relistive) loss at Phion         NA         MIA           SciP Sec - L1212LWI, Voc = 20.0 kV Tr, L = 324A         @ Copport         Q         Copport (relistive) loss at Phion         NA         MIA	C clicati: chink losses for the array Specified by C dickat array clication at 1221 m2 C dickat arts at 127 m2 C dickat arts at 128 m2 C dickat at 128 m2 C dick	Calculated Confault V Coefault V Coefau	etided computation	Middati The we are section server severe and former i i i ingle disconer i i i i i w i dischaft i i i i i i i i i i i i i i i i i i i
Loss fraction at STC 0.10 % 000 mm <sup>2</sup> 00 mm <sup>2</sup> 0	C Clock: chairs losses for the array Social of the array Social of the array Construction at STC Social of the array Construction at STC Social of the array Clock server at the array of the array Clock server at the array of the array Clock server at the array of the arra	Calculated Ordinal: V Confust: V Confust: V Wold system W We exton V Confust: V Con	elaid carputation	MY cast:           The were considerable served were predicted as a served of the served were predicted as a served of the served of th
STC: Pac = 11212 kW, Vac = 20.0 kV Tri, I = 324 A Copper	C circuit: chink: bisses for the array- specified by           Specified by           Gaber array researce           Last starts at ETC           Ways for by arose size with the worker           K there has inverter to bandling core arrows in the worker           K there has inverter to bandling core arrows in the bandling for a arrow in the bandling core arrows in the bandling co	Calculated ordnait: V Conduct Conduct V Conduct V	existed computation     event	NO cardi The very contrast of the second very contrast paradistance C C Ingle disconce C C C Ingle disconce C C C Ingle disconce C C C C Ingle disconce C C C C C C C C C C C C C C C C C C C
Voltage drop at STC 20.7V (0.10%) O Alu Gobal efficiency at Phon	C circuit: chink: bisses for the array- specified by           Specified by           Gaber array researce           Last starts at ETC           Ways for by arose size with the worker           K there has inverter to bandling core arrows in the worker           K there has inverter to bandling core arrows in the bandling for a arrow in the bandling core arrows in the bandling co	Calculated Conduct Co	estiet computation	My cast:           The work output data your           Image: State output data your           Im
	C cleant: chink bases for the array           Specified by           Specified by           Case array researce           Case array researce           Data	Calculated     Ordent      V     Confault      Ordent      V     Confault      Ordent      V     Confault      V	estated compositions Federation Versitagies externant In With Twendriverships, A. device of With Workships Composition Versitagies Composition	Morall         Morall           State         Image: Comparison of the state of t
	C directic chain beamses for the array- specified by         1.1221         mG           © dired array estations at TCC         1.1221         mG           © dired array estations at TCC         1.1221         mG           Withing to the ansate stress dole         0.07         mG           Visions as the the inverter         MG         0.05           Science A charat data the based for three the science and science and the based for three the science and science and the based for three the science and the based for the science and science and science and the based for the science and science and the science and science and the science and science and the science and science and the science and science and the science and science and the science and science and the science and science and the science and science and the science and science and the science and science and the science and science and the science and science and science and the science and sc	Calculated     Ordent      V     Confault      Ordent      V     Confault      Ordent      V     Confault      V	estated compositions Federation Versitagies externant In With Twendriverships, A. device of With Workships Composition Versitagies Composition	Morall         Morall           State         Image: Comparison of the state of t



Power optimizers to be included

٠

٠

On long term allow editing of system from within SLD



Inverter 1

String 1

PVPMC\_2022\_Examples

VC7 : Tracker system 10Mwc Central inv

MyLog

2000 kWac central inverter

27 x Mono 440 Wp Twin 144 half-cell

PVsyst DEV

15/08/22

### **Grid injection limitation**

- If curtailment is imposed on PV systems with inverters that have different DC/AC ratios, it is non-trivial to propagate the curtailment to the MPPT inputs
- The modeling of curtailment has been reviewed and improved for several special cases

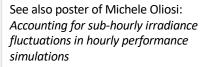
Grid system defnition, Variant VCJ: "Two inverters with differenc DC/AC ratio"			
Sub-array	List of subarrays	(	0
Sub-array name and Orientation Pre-sizing Help Name Low Pnom ratio Order 1 IN No sizing Enter planned power O 0.0 KMP IN IN INC.	1 🕒 🕼 🗸 🔺 🏦 💆		
	ame	#Mod #Stri #Inv. #MPF	
Select the PV module	Low Phom ratio		
Available Now V Filter All PV modules V	Generic - Poly 285 Wp 72 cells Generic - 500 kWac inverter	16 110 1 1	
_Generic ✓ 285 Wp 30V Si-poly Poly 285 Wp 72 cells Since 2015 Typical ✓ Q, Open	High Pnom ratio		
Use optimizer	Generic - Poly 285 Wp 72 cells	16 160	
Sizing voltages : Vmpp (60°C) 31.2 V	Generic - 500 kwać inverter	1 1	
Voc (10°C) 47.1 V			
Select the inverter			
Avalable Now V Output voltage 400 V Tri 50Hz V 60 Hz			
Generic V 500 kW 320 - 700 V LF Tr 50 Hz 500 kWac inverter Since 2012 V Q Open			
No. of inverters I 👔 🖗 Operating voltage: 320-700 V Global Inverter's power 500 kWac Input maximum voltage: 1000 V			
Design the array	Global system summary		
number of modules and schilds	Nb. of modules 4320		
Vmpp (50°C) 523 V	Module area 8382 m <sup>2</sup>		
Vac(inc) 733 V	Nb. of inverters 2		
Nb. strings 110 0 Plane irradiance 1000 W/m <sup>2</sup> O Max. in data   STC	Nominal PV Power 1231 kWp Nominal AC Power 1000 kWA		
Overload loss 0.0 % mpp (STC) 886 A Max. operating power S02 kW Prom ratio 1.00 Stating @ Inspection (STC) 921 A (at 1108 W/m² and 50 °C)	Phominal AC Power 1000 KWAR Phominatio 1.231	-	
	Grid lim. Pnom ratio 1.368		
nu. mounes 1700 Area 3413 m* Ibc (at 3107 921 A Array nom. Power (STC) 302 kmp			
Q, System overview 21- Single-line diagram	🗶 Cancel	🗸 ок	

#### 1000 0 Values from 01/01 to 31/12 Grid limitation 800 Energy injected into grid [kW] 600 Inputs with high DC/AC ratio start clipping 400 200 200 400 600 800 1000 1200 Array virtual energy at MPP [kW]

#### Energy injected into grid vs Array virtual energy at MPP

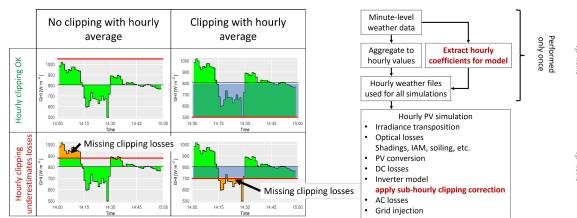
# **Sub-hourly clipping losses**

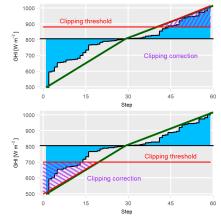
- Sub-hourly clipping losses can be significant with high DC/AC ratios
- We have developed a model that can effectively account for these losses in hourly simulations
- The model requires a one-time pre-analysis of minute-level weather data
- The model will be implemented in PVsyst V8

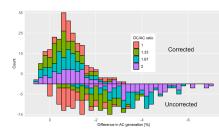


Model published in:

A. Villoz et al., 2022. A Model Correcting the Effect of Sub-Hourly Irradiance Fluctuations on Overload Clipping Losses in Hourly Simulations.
8th World Conference on Photovoltaic Energy Conversion







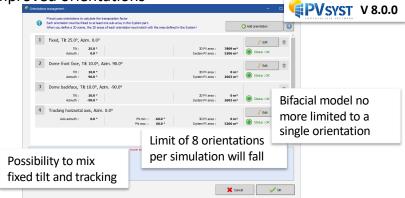


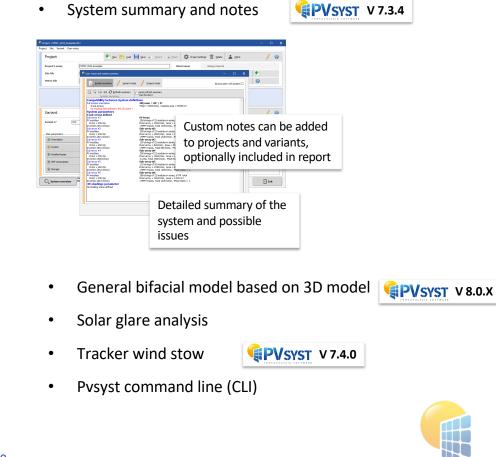
Page 9

### **Other Developments**

- Many Minor Improvements in Results and Report
  - More detailed information
  - More options for customization
  - US date format is now well supported in PVsyst
- Economic evaluation
  - improved management of pricing (feed-in and self-consumption)
  - added the internal rate of return (IRR) value and the possibility to define detailed depreciation parameters

#### Improved orientations





#### **Summary**

- Database updates
  - Built-in Meteonorm 8.1 libraries
  - Improved importing of weather data
  - More power optimizer brands
- Shadings in large systems
  - More options for importing 3D models
  - Improved editing tools
  - Improved performance for large 3D models
- Electrical shading calculations
  - More detail for modern PV module cell layouts
  - Improved simplified models used for large PV systems
- Single line diagram
- Grid limitation (curtailment)

- Single line diagram
- Grid limitation (curtailment)
- Sub-hourly clipping losses
- Other developments
  - More details and customization in results and report
  - More flexibility with orientations
  - Generalized bifacial model
  - Tracker wind stow position
  - Glare analysis
  - Pvsyst command line

• Pvsyst training, video tutorials, social networks, Chinese platforms

